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UbiLAB

Remote Industrial Automation Laboratory Utilizing Augmented Reality

proof of concept

Multiplier Event

Host: Ss. Cyril and Methodius University in Skopje

01.02.2023

Outline

- Introduction
- Industrial automation laboratory
- Ideas for remote learning
- Augmented reality
- Proof of concept
- Future work

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Introduction

- **Institute:** Institute of Automation and System Engineering
- **Study program:** Computer System Engineering, Automation and Robotics
- **Laboratories:**
  - Laboratory for Industrial Automation
  - Laboratory for Control Systems and Robotics
- **Main goal:** enable remote access to stations within our laboratory for industrial automation

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Industrial automation laboratory

- **Courses utilized by this laboratory**
  - Manufacturing plants and Process Automation
  - Programmable Logic Controllers (PLC)
  - Distributed Control Systems and SCADA

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Industrial automation laboratory

- **Total of 8 stations for practicing industrial automation subjects**

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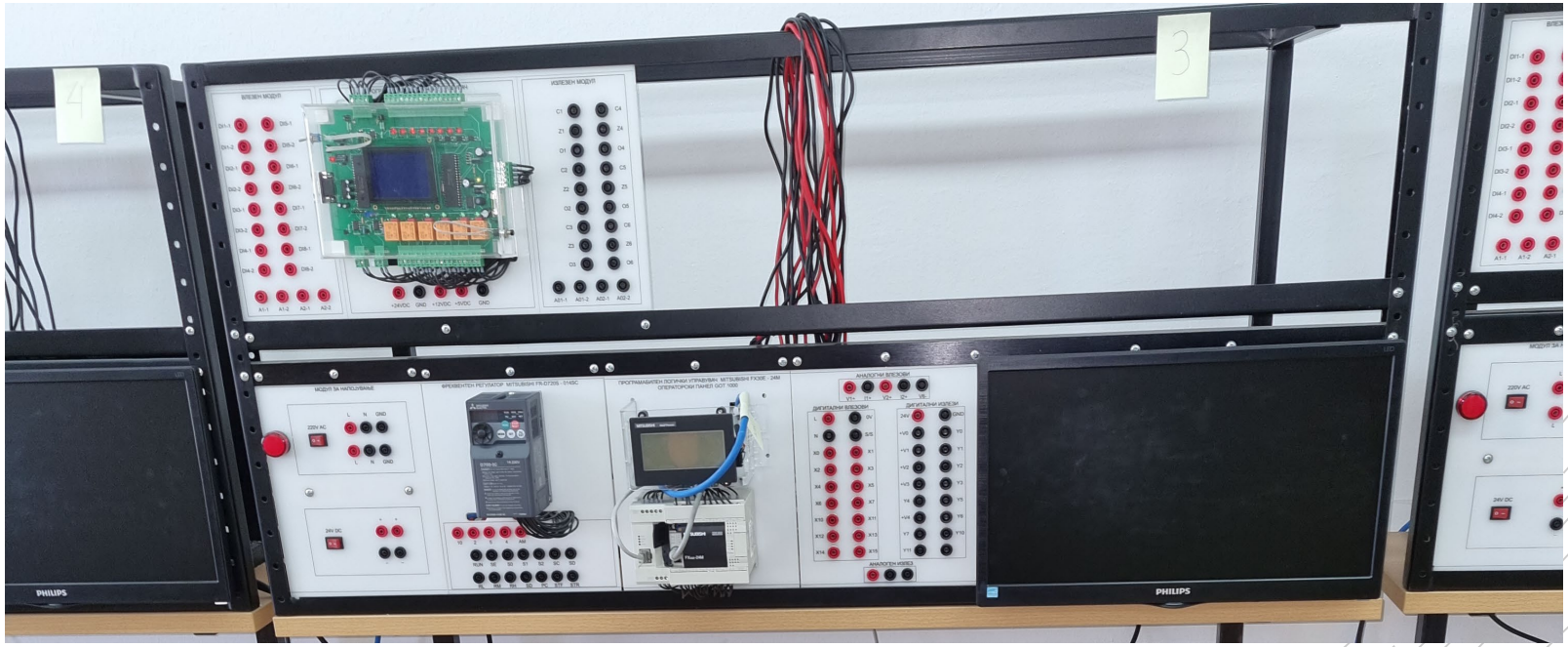
Industrial automation laboratory

- **Equipment:**
  - Student-made PLC
  - Mitsubishi PLC
  - Variable Frequency Drive (VFD)
  - Human Machine Interface (HMI)
  - Personal computer



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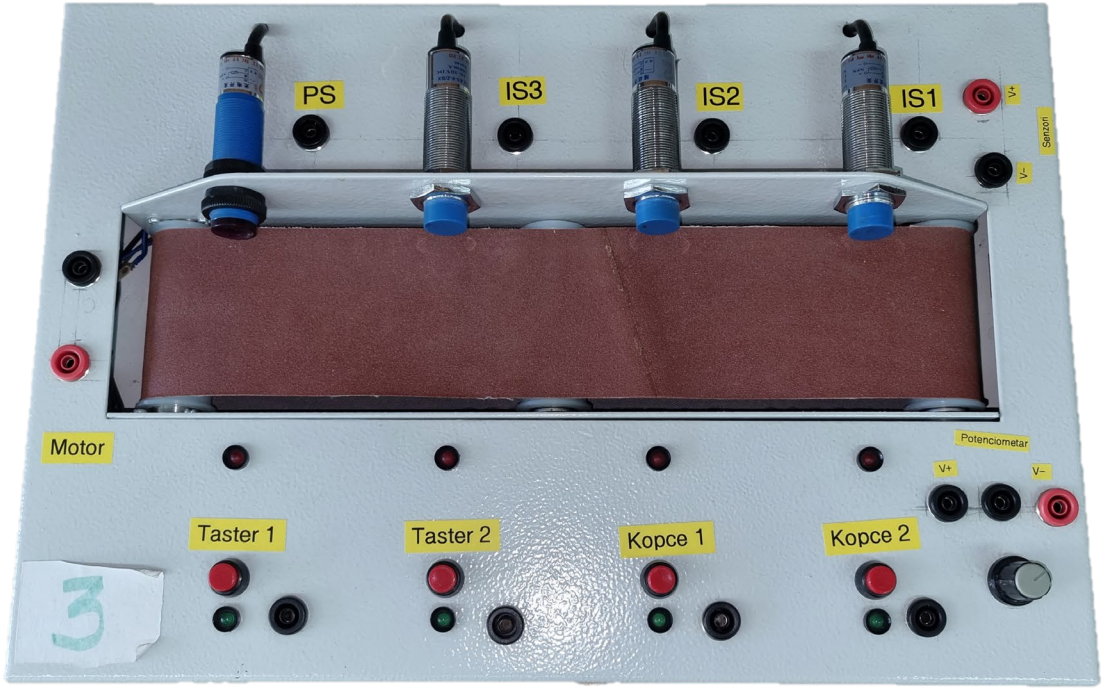
Industrial automation laboratory

- **Plant model:**
  - Conveyor belt
  - Inductive and photo sensors
  - Momentary and maintained push switches
  - Potentiometer



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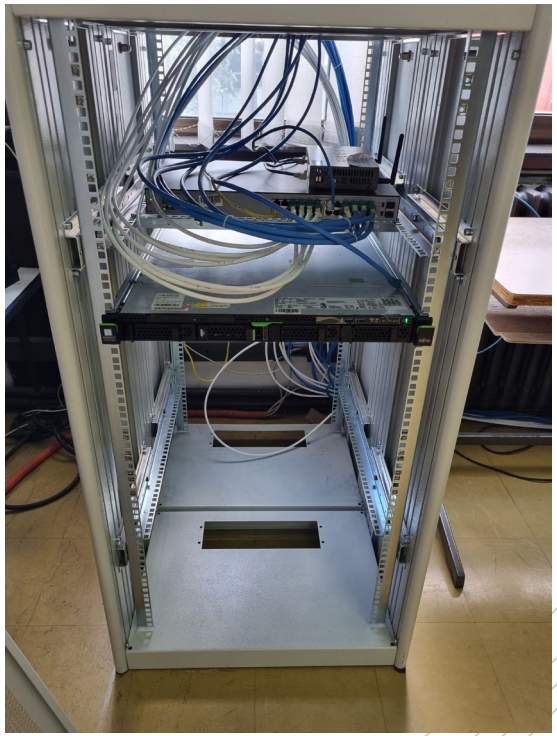
Industrial automation laboratory

- **Additional equipment:**
  - Server
  - Network router
  - Network switch
- Each PLC and PC are connected within a LAN



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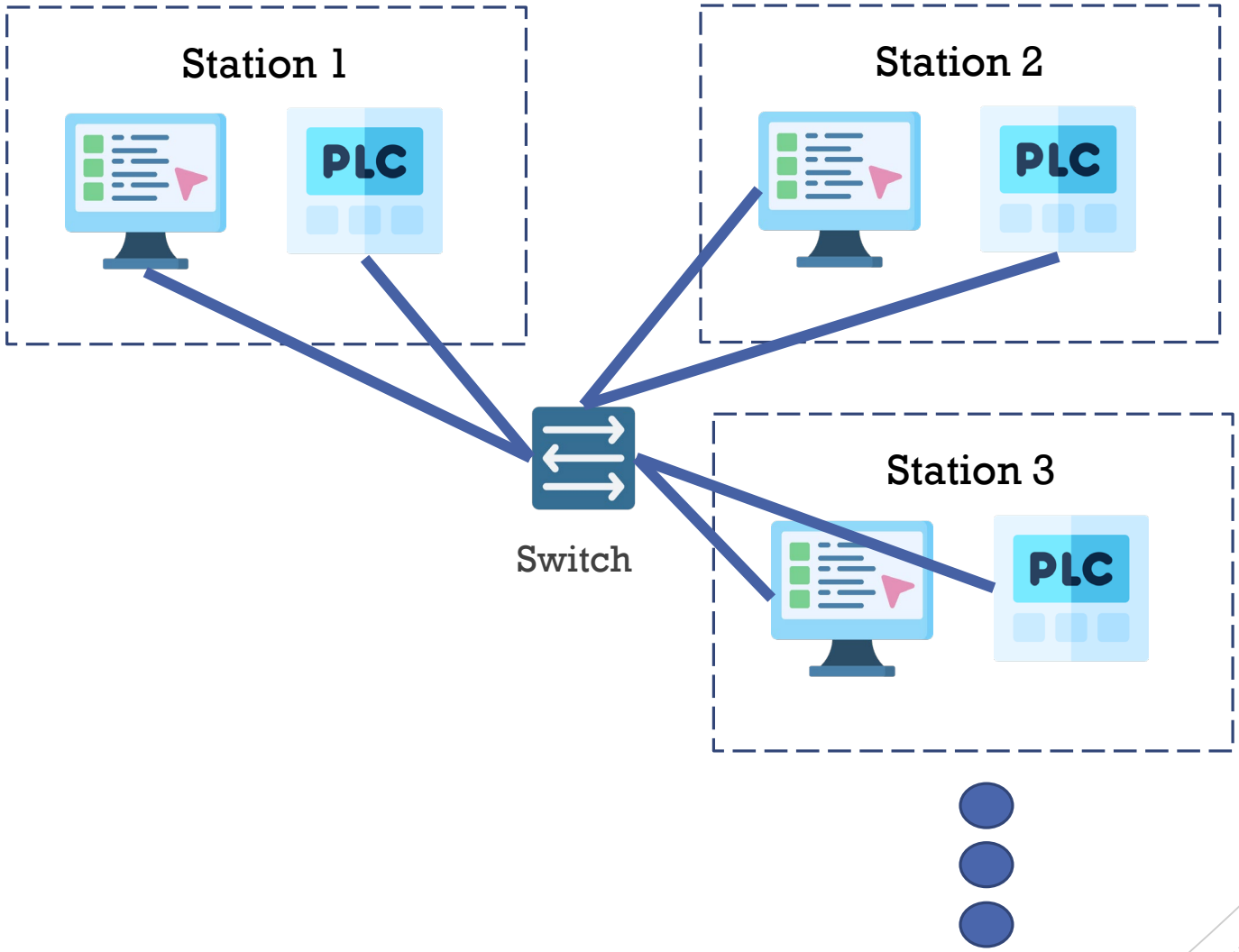
Industrial automation laboratory

- **Each PLC and PC are connected within a LAN**



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Industrial automation laboratory

- **Plant model for transportation of fluids**
- Not a subject of the project

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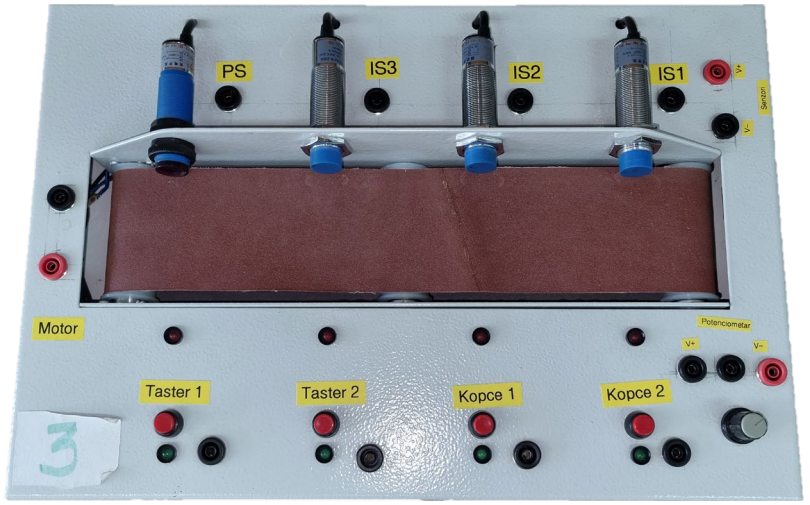
Ideas for remote access

- **Remote learning through custom simulated environment automated by real equipment**
- **Pros**
  - Access to real equipment through programming the PLC and observing it through remote cameras
- **Cons**
  - Lack of interaction with real equipment



Simulated plant communicating with real PLC

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Ideas for remote access

- **Remote learning through simulated environment using proprietary software**
- **Pros**
  - Detailed industrial environment with large palette of sensors and actuators
  - Allows interaction with the environment
  - Good for student projects and laboratory exercises
- **Cons**
  - Lack of interaction with real equipment

Ideas for remote access

- **Our proposal**
- Utilize the same laboratory equipment and enable interaction with it through augmented reality

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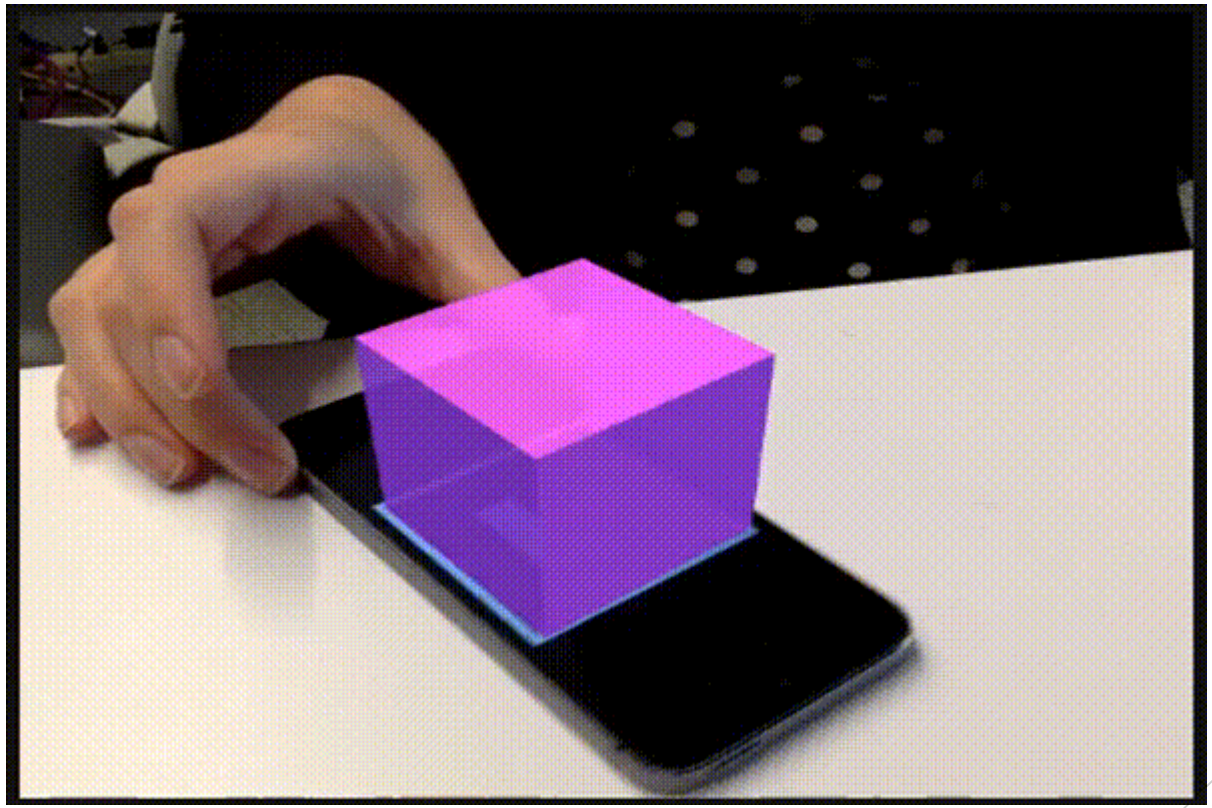
Augmented reality

- A technology that imposes a virtual creation on an image of the real world



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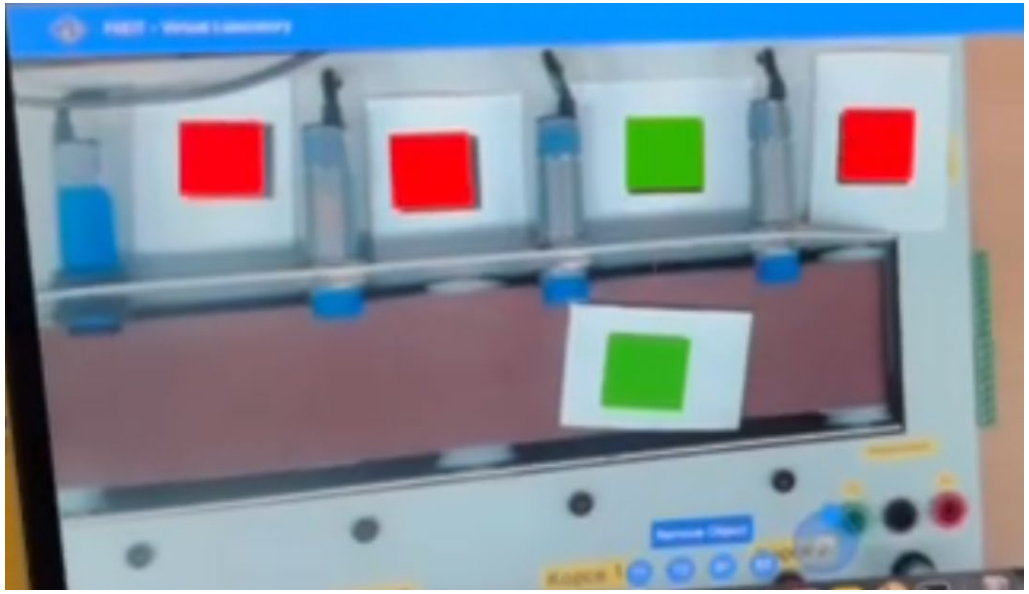
Augmented reality

- Impose virtual objects and sensors on real plant model within the laboratory



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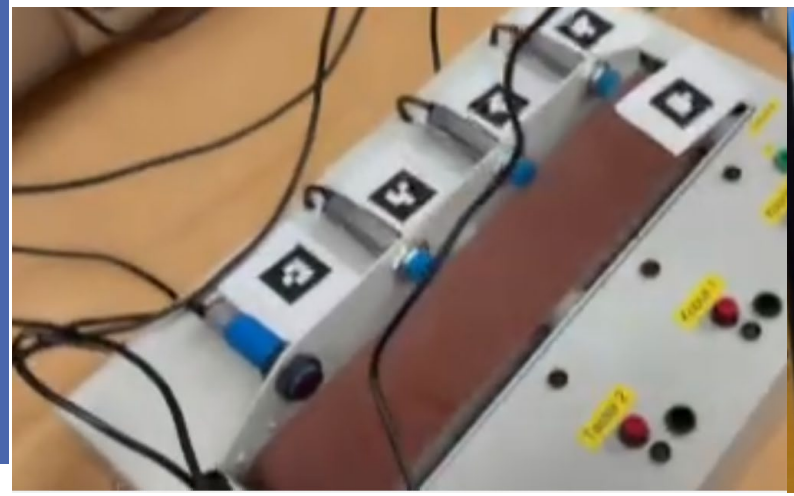
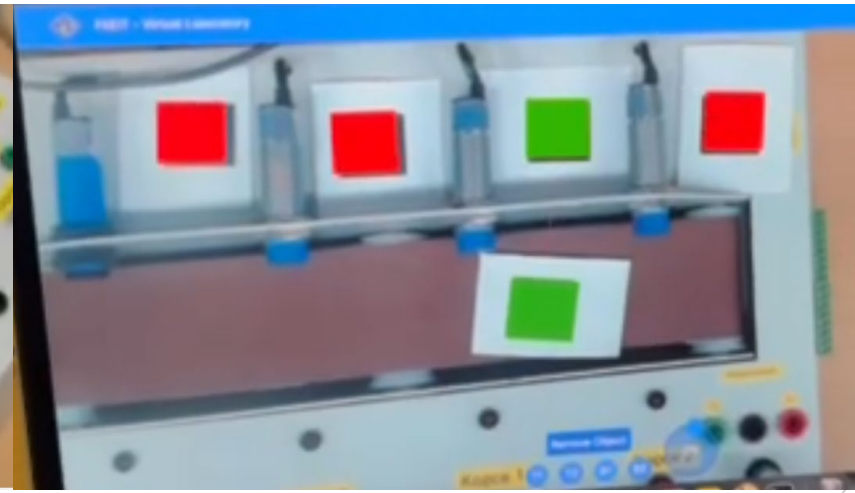
Augmented reality

- **How does it work in our case?**
- Introduce printed markers for each sensor and object
- Through image processing: identify each sensor's location and impose virtual objects on to the conveyor





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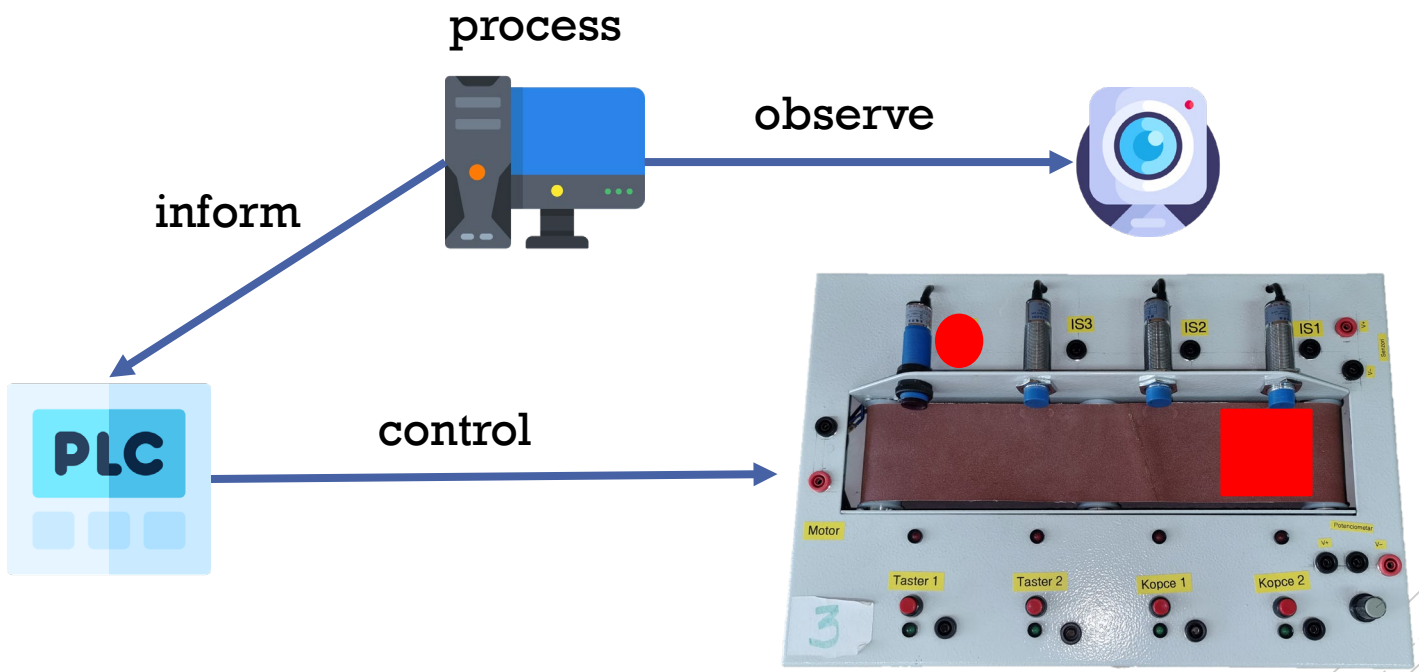
Proof of concept

- Identify virtual object's location in reference to virtual sensors
- Notify PLC when object is in front of sensor
- PLC will act according to its program uploaded by the student



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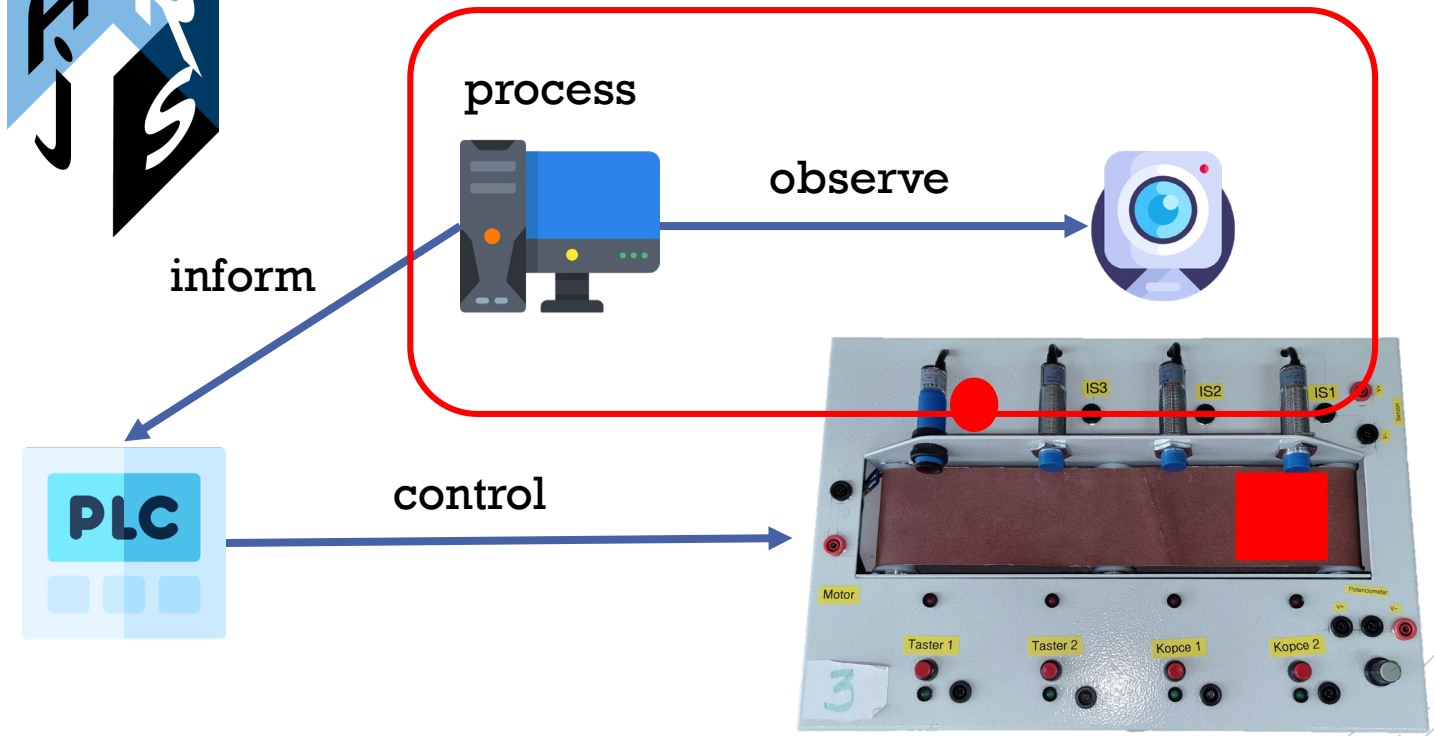
Proof of concept

- The remote access was intended as a web application
- Consequently we utilized AR.js
- AR.js is a lightweight library for Augmented Reality on the Web, which includes features like Image Tracking, Location based AR and Marker tracking.



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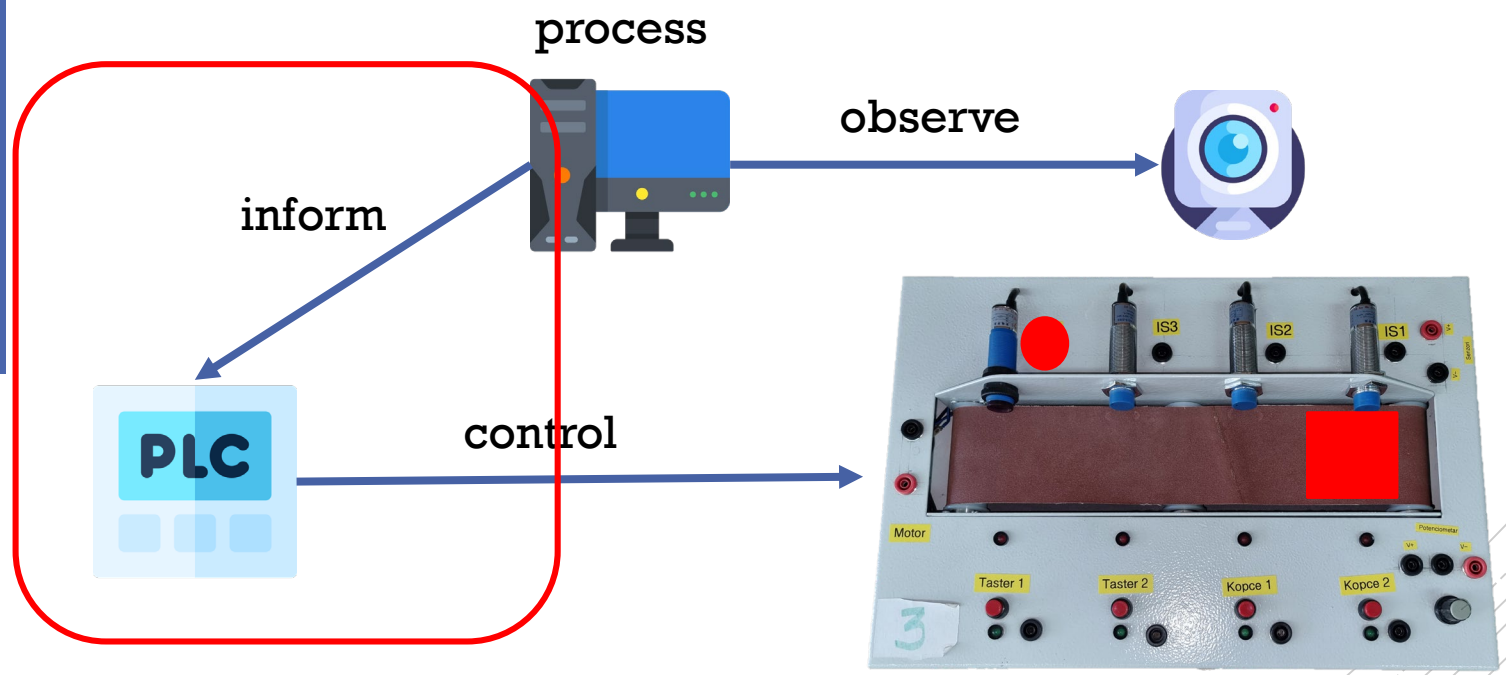
Proof of concept

- The PLC is Mitsubishi FX3GE
- It allows communication through its own protocol called MC protocol using ethernet
- We developed a python library for communication based on this protocol
- This way we can change memory bits, registers and outputs within the PLC



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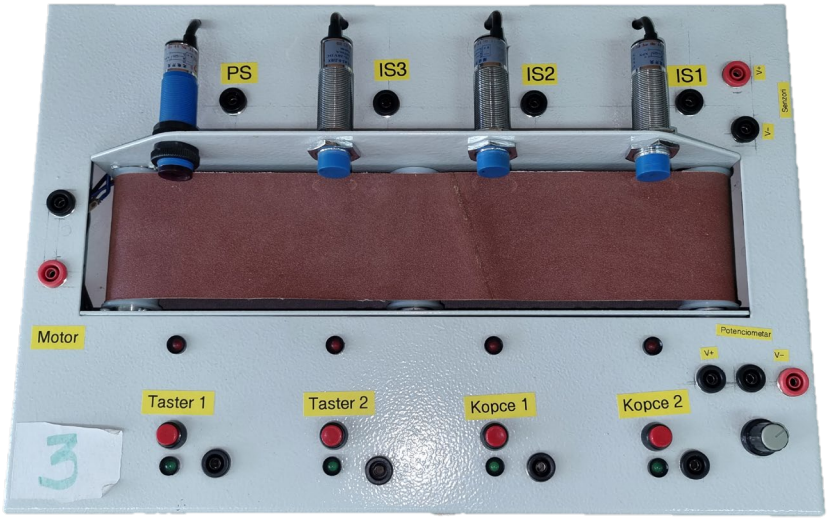
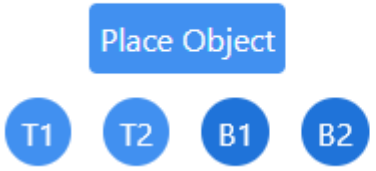
Proof of concept

- Graphical user interface through the website





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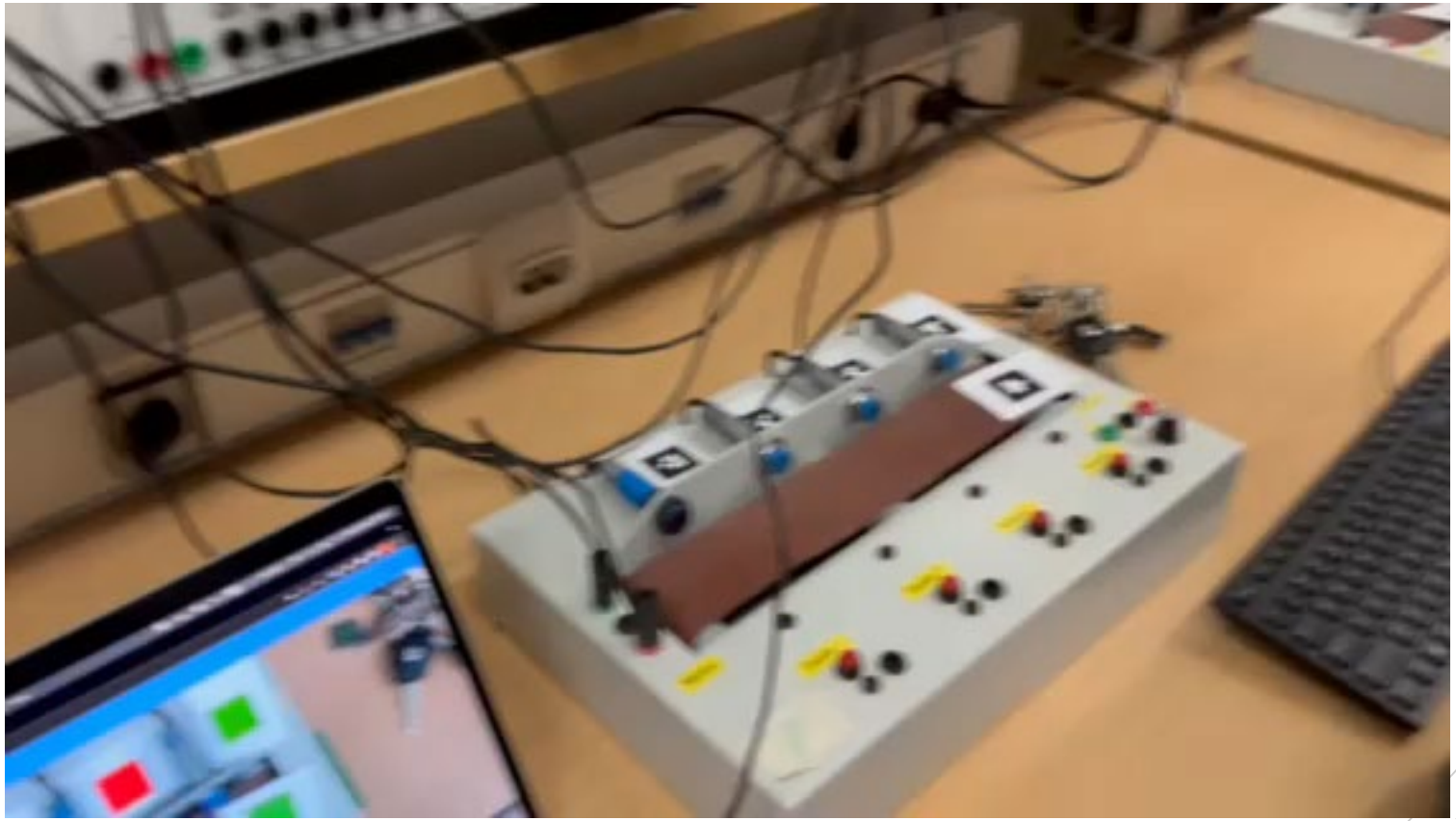
Proof of concept

- Demonstration



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Future work

- Implement and test the web application on a server using IP camera
- Implement access through Moodle and Guacamole
- Include possibility for multiple virtual objects
- Include interactive drag & drop type positioning of virtual objects
- Add metallic and non-metallic virtual objects and sense them according to the appropriate sensors

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Thank You!

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